Biographical Information

Judd Muskat
Research Program Specialist (GIS)
California Department of Fish and Game
Office of Spill Prevention and Response

Specific Responsibilities

Mr. Muskat's primary responsibilities at OSPR include geographic information system (GIS) support for oil spill contingency planning, field deployment of GIS during emergency oil spill response, GIS support for natural resource damage assessment (NRDA), GIS technology training and research project management. Mr. Muskat's current research involves the use of remote sensing technology for oil slick detection. Mr. Muskat joined the California Department of Fish and Game, Office of Spill Prevention and Response in September, 1993.

Past Experience

Mr. Muskat is an Earth Scientist with experience in pollution incident response and mitigation; GIS project management, remote sensing, electronic field data collection, geotechnical field testing and sampling. He has significant experience actively exploring for and developing oil and gas and geothermal energy resources. Mr. Muskat also has significant experience with Geotechnical, and Environmental project management.

Educational Experience

MS, Geology, 1983 - California State University, Northridge, CA
BA, Geology, 1976 - Humboldt State University, Arcata, CA

Professional Memberships

American Association of Petroleum Geologists
American Society for Photogrammetry and Remote Sensing

GIS IMAGERY FOR NATURAL RESOURCE DAMAGE ASSESSMENT

Judd Muskat
California Department of Fish and Game
Office of Spill Prevention and Response
1700 “K” Street
Sacramento, CA 95814
jmuskat@dfg.ca.gov

ABSTRACT

On April 27, 2004 a 14” hazardous liquid pipeline ruptured spilling over 100,000 gallons of diesel fuel into the Suisun Marsh, a part of the San Francisco Bay ecological area. The break occurred in a pipeline that runs through the 55,000-acre Suisun Marsh, California's largest wetland and a Pacific Flyway haven for more than a million migrating and resident shorebirds and waterfowl. The pipeline carries diesel, jet fuel and gasoline from Bay Area refineries to Concord, Sacramento, Rocklin, Chico, and Reno. GIS was employed by the Unified Command to manage, map, analyze and display convergent data for the emergency response. Working cooperatively with, but technically separate from the emergency response, the trustee agencies and the responsible party undertook several natural resource damage assessment (NRDA) data collection efforts and studies. One study used a multispectral digital camera that was flown over the spill site on two dates several weeks apart. Interpretations from these images helped to quantify acreage affected by the pipeline release. This paper will describe methodologies employed by the California Department of Fish and Game, Office of Spill Prevention and Response and show specific examples from the Suisun Marsh oil spill response and natural damage resource assessment.

INTRODUCTION

The Office of Spill Prevention and Response (OSPR) is within the California Department of Fish and Game (CDFG). The grounding of the “Exxon Valdez” followed by a lightering mishap off of Huntington Beach, California involving the tanker *American Trader* prompted the Lempert-Keene-Seastrand Oil Spill Prevention and Response Act[*] of 1990 which established the Office of Spill Prevention and Response. OSPR retains the Department of Fish and Game's public trustee and custodial responsibility for protecting and managing the State's fish, wildlife, and plants. CDFG is the lead State agency charged with oil spill prevention and response within California's marine environment.

[*] A detailed compendium of this Act can be viewed at the OSPR World Wide Web site http://www.dfg.ca.gov/Ospr/index.html.

The OSPR Administrator has substantial authority to direct spill response, cleanup, and NRDA activities. Trustees use NRDAs to assess injury to natural resources and scale the compensatory restoration owed to the public. This is an initial step toward restoring injured resources and services lost as a result of the incident.

Specifically for spill response, OSPR maintains a field GIS consisting of Microsoft Windows based laptop computers running ESRI GIS software. Peripheral devices such as external hard drives, color printers and large format plotters are routinely brought to the field. This mobile GIS is deployed from Sacramento for drills, exercises and emergency oil spill response. The standard vehicle for a multi-agency oil spill response is the Incident Command System (ICS). In the ICS organization, GIS technical specialists are inserted as part of the Planning Section (USCG Incident Management Handbook*).

SUISUN MARSH

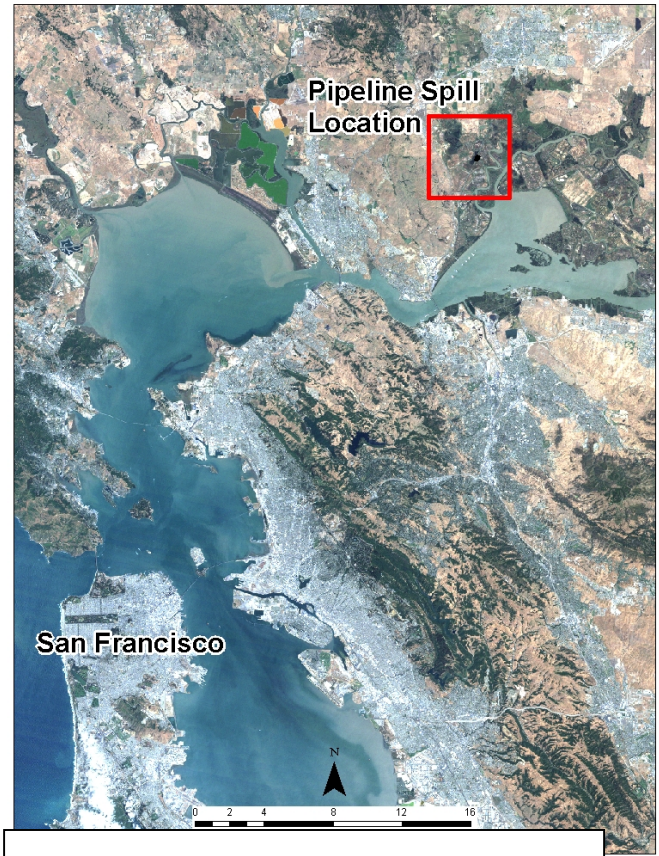


Figure 1 Suisun Marsh is located about 35 miles northeast of San Francisco.

Suisun Marsh (Figure 1) is part of the San Francisco Bay-Delta estuary ecosystem. Encompassing approximately 116,000 acres it is the largest contiguous brackish water marsh remaining on the west coast of North America. The Suisun Marsh includes managed wetlands, upland grasses, tidal wetlands, and bays and sloughs. It is home to public waterfowl hunting areas and 158 private duck clubs. The Marsh encompasses more than 10% of California's remaining natural wetlands and serves as the resting and feeding ground for thousands of waterfowl migrating on the Pacific Flyway**.

* The complete text of this handbook is available at http://www.uscg.mil/hq/g-m/mor/page2index.htm

** California Department of Water Resources website http://www.iep.ca.gov/suisun/

GIS at the Suisun Marsh Pipeline Spill Response

On April 27th 2004 a diesel fuel spill occurred in Suisun Marsh. A 14-inch pipeline ruptured and released over 100,000 gallons of diesel fuel into the environment. The break occurred in a managed area where a series of levees and channel gates contained the spill within a 220-acre private duck club. Initial estimates of the volume of product released into the marsh necessitated a large and rapid response. OSPR, the U.S. Coast Guard and other federal, state and local agencies responded and filled the basic ICS positions. The USCG Federal On-Scene Coordinator requested GIS support from OSPR to manage and display the convergent data being generated by the multi-agency response.

As the response escalated shoreline cleanup assessment teams (SCAT) were formed to recon the site impacts. A wildlife operations branch was formed to manage wildlife search and collection, and a wildlife hazing plan was put in place to scare birds away from the affected area. Diesel-fouled water was collected in trenches, skimmed and stored in nearby Baker tanks for later quantification.

Recent aerial imagery or high resolution base maps were not available so the responsible party (RP) contracted for a high resolution digital aerial image. This image was delivered to the command post then georeferenced using ArcGIS. This proved to be the best base map for field responders and briefing displays.

Some of the GIS layers that were generated on-scene at this response and for the NRDA data collection included; operational division boundaries and extents, wildlife collection locations, wildlife hazing locations, groundwater monitor well locations, degree of oiling and channel cleanup status from SCAT reports, staging areas and deployed equipment locations, benthic macro invertebrate sample locations.

Field data collection teams were encouraged to provide GPS coordinate information along with their field report. Upon return to the incident command post the field responder's GPS receivers were downloaded and ideally a field log, notes or field map was provided to the GIS technical specialist.

GIS and Natural Resource Damage Assessment (NRDA)

The emergency response and cleanup effort lasted for several weeks. Some GIS data generated as part of the response and cleanup effort was also used for the concurrent but independent cooperative NRDA. The trustee agencies and the responsible party undertook several NRDA data collection efforts and studies. One study used a multispectral digital camera that was flown over the spill site on two dates several weeks apart. Interpretations from these images helped to quantify acreage affected by the pipeline release.

Multispectral Imagery Acquisition and Analysis

OSPR has ongoing research projects with Ocean Imaging Corporation* (OI) utilizing OI's 4-channel DMSC-Mk2** aerial sensor. This small scale optical instrument records the spectral reflectance characteristics of vegetation and soils on the ground and oil films on water. This is a portable system that operates from CDFG's light aircraft flying between 3,000 feet and 10,000 feet.

As part of the cooperative NRDA the responsible party contracted OI to utilize its remote sensing resources and expertise to map vegetation and substrate change in and around the region of the Suisun Marsh diesel spill (Figure 2). Two missions were flown; the first was on May 18, 2004 and the second on July 15, 2004. The focus was on identifying three prime changes: 1) areas which were flooded in May but had no standing water in July; 2) areas which were vegetated in May but turned to bare soil by July; 3) areas which experienced significantly decreased chlorophyll vigor (as measured by a change in the Normalized Difference Vegetation Index (NDVI) computed from the multispectral data) between May and July. Two GIS-compatible product files were produced from the change detection analysis (Figure 3, 4): 1) "bare space analysis and major vegetation stress" results - indicating where vegetation was gained or lost and

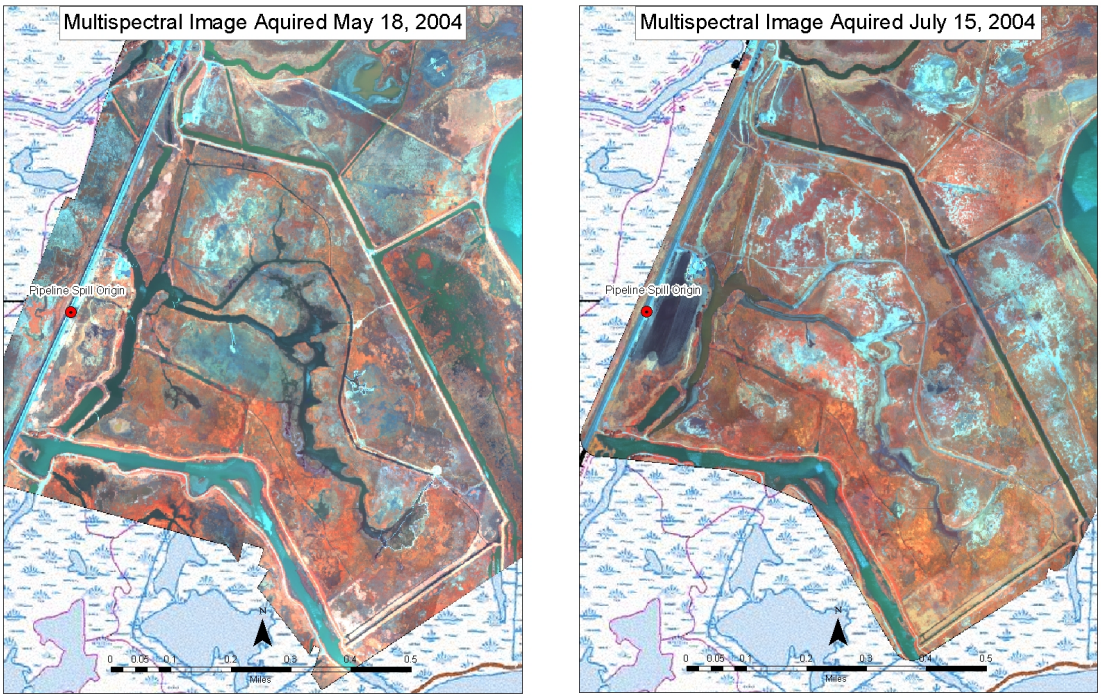


Figure 2 Multispectral images of the Suisun Marsh acquired for the cooperative NRDA.

* www.oceani.com

** Manufactured by SpecTerra Systems
http://members.westnet.com.au/specterr/dmscmk2_frame.html

which areas were covered by

water in May but were dry due to draining by July. Also included in this product is a class indicating "significant vegetation stress", as measured by major decreases in NDVI index between the two flights. In some areas, change was indicated by both the bare space and the NDVI analysis - and this is indicated by an "intersection" class; 2) an analysis product showing the NDVI change results separately, with 3 levels of stress separated to provide a relative sense of intensity. The products were electronically delivered to all groups involved in the spill incident on 8/11/2004.

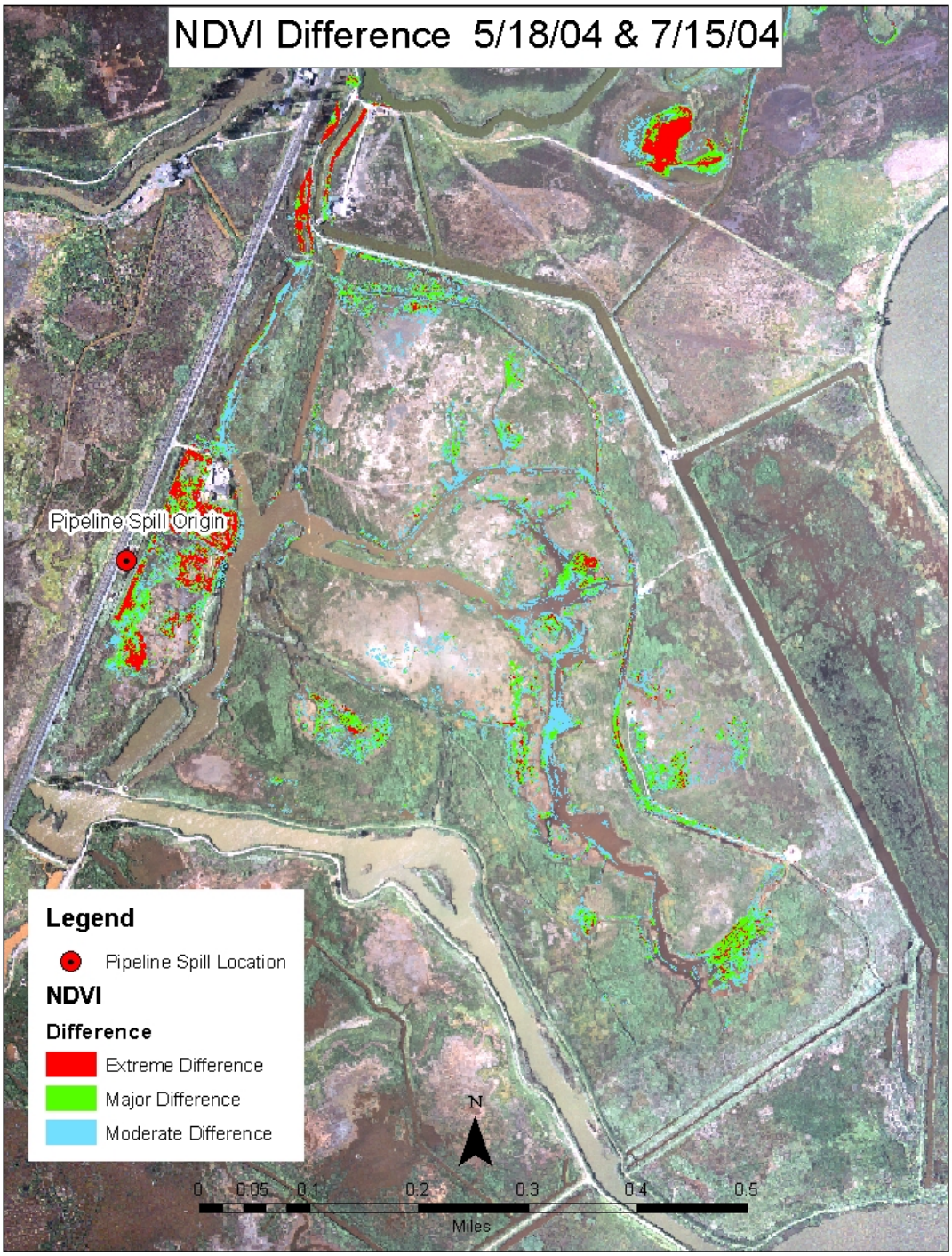
Use of GIS Imagery in the HEA Determination

For the initial Habitat Equivalency Analysis[***] (HEA) determination the trustee agency representatives gathered in a conference room at the OSPR offices in Sacramento. A GIS workstation and a computer projector were set up to display the data on a dry marker white board. A data evaluation session occurred where the various NRDA participants each took their turn at drawing polygons depicting various levels of disturbance around the spill site as the remote sensing images and other GIS data sets were displayed. As the polygons were drawn they were digitized into the GIS. By digitizing GIS polygons on the fly accurate acreage values were generated in real time by the GIS software. This interactive process was very efficient in that the trustees were able to make their injury determinations together interactively while viewing all significant GIS data sets related to the response and cleanup.

CONCLUSION

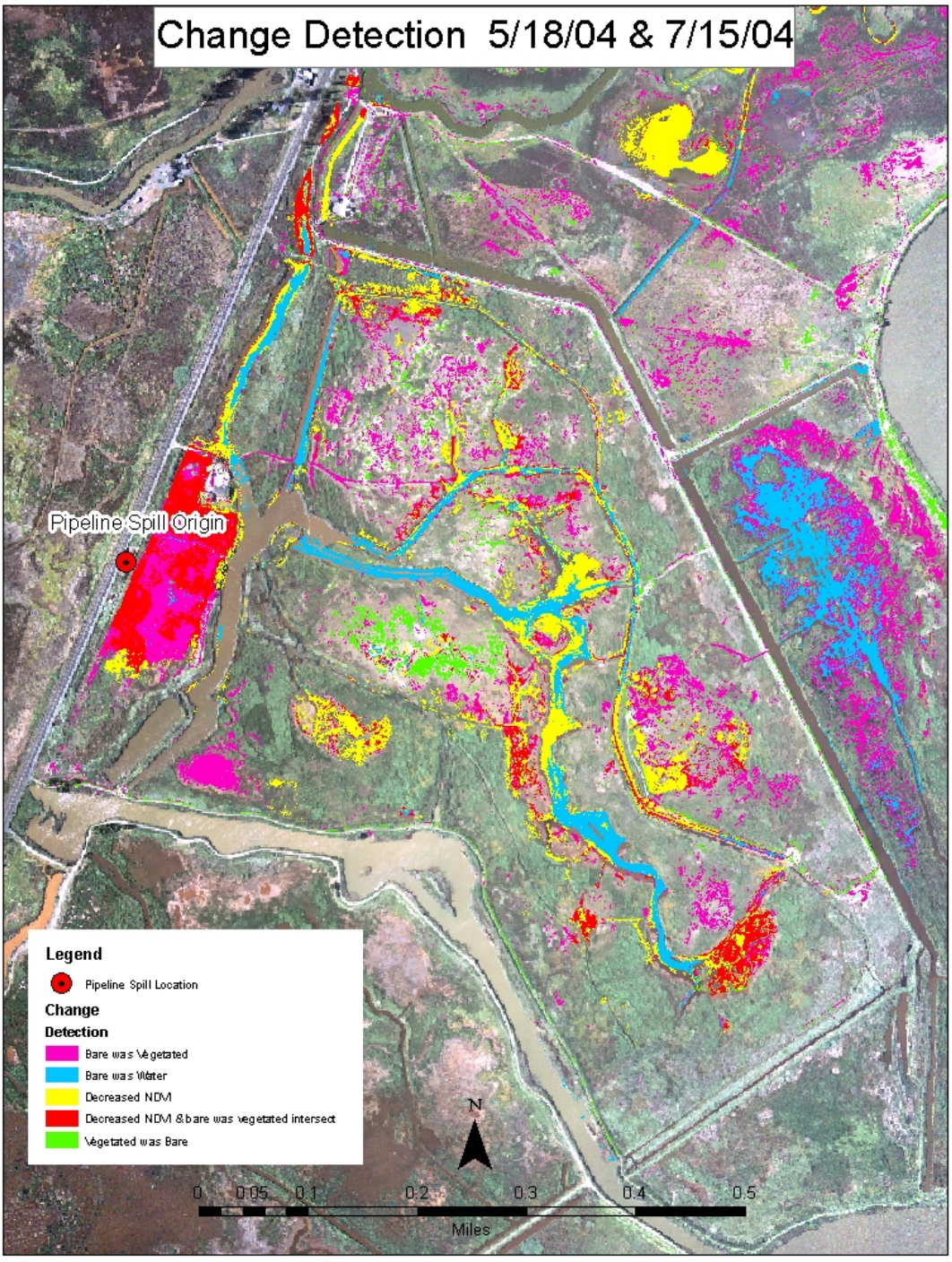
GIS technology is imbedded in oil spill response in California. GIS data sets created or collected at the Suisun pipeline spill emergency response and cleanup along with GIS remote sensing image interpretations and other studies specific to the NRDA effort were post processed, interpreted, collated and used for input into the HEA determination. The Suisun Marsh work exposed some detection considerations primarily, timing of the initial remote sensing overflight which occurred a full three weeks after the initial pipeline release. Obtaining image data immediately after the accident may help alleviate complications faced in the Suisun case where some vegetation was already dead at the time of the first overflight and, with no direct signal from the diesel film itself, was thus difficult to differentiate from other dead vegetation not related to the spill.

[***] http://www.darp.noaa.gov/library/1_d.html



Images classified by Ocean Imaging Corp.

Figure 3 NDVI difference between 5/18/04 and 7/15/04.



Images classified by Ocean Imaging Corp.

Figure 4 Vegetation change detection between 5/18/04 and 7/15/04.